

**Method and System for Interactive Visual Analyses of
Organizational Interactions**

Background Of The Invention

One of the most valuable assets of a company, if not the
5 most critical one, is its intellectual capital which, among
other things, includes human assets. A company can maximize its
intellectual capital only if it understands its key elements and
how these elements interact with each other to add value to the
company. Understanding the nature of the interactions between
10 these elements can reveal significant information about and for
the company. More and more companies today acknowledge the
importance and relevance of such interactions, and allocate
significant resources to analyze and utilize these interactions.
Successful companies manage to extend these interactions well
15 beyond the company boundaries by analyzing interactions with
customers, partners, suppliers and alliances as well.
Essentially, such interactions, whether explicit or implicit,
define specialized human networks with complex organizational
dynamics.

20 While the importance of human networks is well understood
for effective organizational management, existing methodologies
by which such networks can be analyzed are not well-defined.
Existing methodologies generally rely on statistical sampling

and/or informal opinion polling techniques which are neither complete nor reliable. Typically, they are ad hoc and do not include the entire target population in analyses. Furthermore, existing methodologies focus on qualitative rather than quantitative analyses of organizational interactions.

What is desired, therefore, is a systematic approach that captures multi-faceted nature of organizational interactions, provides qualitative and quantitative measures in analysis, maps analysis objectives to well-defined process steps, and guides the process while allowing analysts to steer the analysis for particular objectives.

Summary Of The Invention

The purposes of the invention described above and other objects are achieved by a method for interactive visual analysis of interactions among entities, where entities are individuals or groups. The method includes collecting interaction data, processing the collected interaction data with connectivity and diversity measures, and displaying the processed as well as the raw interaction data to facilitate various interaction analyses.

In the preferred embodiment of the system for interactive visual analysis of interactions among entities, where entities are individuals or groups, the system includes: a computer having a microprocessor and a storage unit; a database

electronically coupled to the computer for storing interaction data, auxiliary information and any additional data derived from the interaction data; algorithms operable by the microprocessor for measuring connectivity and diversity of entities based on
5 their interactions; a set of programs for accessing interaction data and generating views dynamically; a display screen electronically coupled to the computer for providing a user interface, the user interface providing appropriate controls for displaying and interactively manipulating each generated view; a
10 user input device electronically coupled to the computer; and a user selectable element of the user interface being responsive to user input via the user input device to generate a report based on analysis results.

Brief Description Of The Drawings

15 **FIG. 1** shows a flow diagram illustrating the preferred embodiment of the interactive visual analysis methodology of the present invention.

FIG. 2 shows an organization view under view generation of the interactive visual analysis methodology of **FIG. 1**.

20 **FIG. 3** shows another organization view under view generation of the interactive visual analysis methodology of **FIG. 1**.

FIG. 4 shows a group view under view generation of the interactive visual analysis methodology of FIG. 1.

FIG. 5 shows an individual view under view generation of the interactive visual analysis methodology of FIG. 1.

5 FIG. 6 shows the individual view of FIG. 5 at a higher depth value.

FIG. 7 shows a cluster view under view generation of the interactive visual analysis methodology of FIG. 1.

10 FIG. 8 shows a people map under view generation of the interactive visual analysis methodology of FIG. 1.

Detailed Description Of The Preferred Embodiment

15 Figure 1 is a flow diagram illustrating the preferred embodiment of the interactive visual analysis methodology of the present invention. This methodology structure includes data collection, generally indicated by reference numeral 100, data analysis and processing, generally indicated by reference numeral 110, view generation, generally indicated by reference numeral 120, and interaction analysis, generally indicated by reference numeral 130.

20 Data collection 100 includes accumulating interaction data by employing appropriate data collection mechanisms. For example, sources of interaction data include, but are not limited to: (1) Network surveys which poll an entire target

population, including people within or outside an organization;
(2) E-mail traffic with or without content-based classification;
(3) Phone traffic; and (4) Access to shared resources, including
but not limited to, files, documents, programs and systems.

5 Database analysis and processing 110 includes processing
the collected interaction data with auxiliary data, such as
employee, client, product and/or content data. This step may
also include applying statistical, heuristic or clustering
techniques -- using appropriate measures, strategies and
10 benchmarks -- to the processed data, and deriving additional
data to enhance and enrich the processed data. There are two
important concepts here: connectivity and diversity measures.

Connectivity is a measure for assessing how well entities
are connected to their environment. "Entity", as used herein,
15 includes individuals as well as groups, such as a department
within an organization. Generally, the connectivity measure is
a recursive measure that uses an appropriate decay factor for
accounting the effects of indirect connections (or interactions)
up to a certain level of depth. Connectivity may be measured in
20 different ways. The following general formulation may be used
as a basis for connectivity analysis:

$$C(E, L) = \sum_{1 \leq k \leq N} [w(k) + C(k, L-1)/f_d] \quad C(E, 0) = 0$$

In this formula, $C(E, L)$ denotes connectivity of entity E at depth L where E has N direct connections (interactions), $w(k)$ is the weight of direct connections from k , and f_d is the decay factor. While several alternatives exist for decaying the effects of indirect connections, typically either a distance-based measure or a degree-based measure is used as a decay factor.

Diversity is a measure for assessing how diverse entities are in their interactions with or connections to their environment. As with the connectivity measure, the diversity measure is also a recursive measure that uses an appropriate decay factor for accounting the effects of indirect interactions (connections) up to a certain level of depth. Depending on analysis needs, diversity may be measured along dimensions, such as age, gender and business types. Diversity may be measured in different ways. The following general formulation may be used as a basis for diversity analysis:

$$D(E, L) = \sum_{1 \leq k \leq N} [v(k, p) + D(k, L-1)/f_d]$$

$$D(E, 0) = 0$$

In this formula, $D(E, L)$ denotes diversity of entity E at depth L where E has N direct connections (interactions), and $v(k, p) = 0$ if the property of k along the diversity dimension of interest is already within p , where p is a set of properties

encountered so far, including the property of E. Otherwise,
v(k,p) = 1. Again, f_a is the decay factor for adjusting the
effect of indirect connections. Using connectivity and
diversity measures in heuristic rules, the data analysis and
5 processing step may also classify entities in a given network
into categories outlining the criticality of entities in the
network.

View generation 120 involves generating views corresponding
to different depictions of the interaction data after the
10 analysis and processing of step 110. Since these views are
related and provide different aspects of the same data,
appropriate interactive mechanisms are also provided to move
from one view to another. In the embodiment of FIG. 1, there
are six different types of views provided. Each and every one
15 of these views is for exemplary purposes only, and it should be
apparent to one of ordinary skill in the art that modifications
may be made to these exemplary views without departing from the
scope or spirit of the present invention.

First, an organization view arranges selected
20 organizational units hierarchically, where units are represented
in terms of graphical objects encoding certain data attributes
using objects' graphical properties. An exemplary organization
view is shown in Figure 2, where color and location of each
square box encode the relative position of the corresponding

unit within an organizational hierarchy. While boxes on the innermost rectangle (layer) correspond to higher-level (parent) units, boxes on the outer layers correspond to lower-level (sub) units. Color of boxes simply encode the 'part of' relationships
5 between units at different layers. While the size of a box represents a scalar value such as the degree of internal and external interactions of members of the corresponding unit, the gray area within each box shows the portion of internal interactions.

10 In an organization view as shown in FIG. 2, any box can be selected to see how the corresponding unit interacts with other units, which is conveyed in terms of directed links having varying thickness. The direction and thickness of a link encode the direction and strength of interactions between two groups
15 connected by the link. Besides one-to-many interactions between a selected unit and the rest, many-to-many interactions among selected units can also be displayed within an organization view as shown in Figure 3.

A second type of view provided in the example of FIG. 1 is
20 a group view. Group view displays individual members of selected units along with their relevant attributes within a context, as illustrated in Figure 4. In a group view, individuals are enclosed within a large bounding box having the same color as the selected unit in the organization view. In

order to provide a context for the selected unit, all units that are at the same level as the parent of the selected unit are shown on a line at the top of the view. All units having the same parent as the selected unit are also shown on a line at the bottom of the view. The leftmost boxes on the top and bottom lines correspond to the parent and the selected units, respectively. As in an organization view, entities in a group view are represented in terms of graphical objects, such as boxes that are arranged hierarchically. While the size of a box represents a scalar value, such as the degree of internal and external interactions of the corresponding individual, the color may be used to encode additional attributes, such as gender, location or criticality classification.

A third type of view provided in the example of FIG. 1 is an individual view. Individual view represents an interaction record (print) of a selected individual. By definition, an individual's interaction print consists of directed interaction of that individual with others. "Directed interaction", as used herein, implies that the interaction is initiated by an individual who is the source and has a target as another individual who is the sink. Generally, an interaction print is a recursive structure representing direct and indirect interactions of an individual. In an individual view, each square represents an individual. While the largest square

corresponds to the individual whose interaction print is on display, the squares to the right and to the left having the same vertical positioning (i.e., on the same horizontal line as the largest square) represent individuals who are sources and
5 sinks, respectively.

Then, for each individual who is either a source or a sink, a separate interaction print with one less depth level is created by listing the individuals who interact with that individual as sink above and as source below the individual's
10 box having the same horizontal positioning (i.e., on the same vertical line). Repeating the process N times essentially creates an interaction print having a depth value which equals to N. In Figures 5 and 6, two interaction prints, one with depth=2 and the other with depth=4, are shown.

15 A fourth type of view provided in the example of FIG. 1 is a cluster view. Cluster view defines hypothetical groups within an organization based on existing networks. These hypothetical groups or clusters may be formed either by applying appropriate clustering techniques to the interaction data or moving people
20 from one group to another in the current organization manually. In a cluster view, the composition of clusters are shown in terms of pie charts as illustrated in Figure 7. It should be apparent to one of ordinary skill in the art that the use of pie charts is for exemplary purposes only and is not limited

thereto. In a way similar to the display of interactions among units in an organization view, interactions between clusters are conveyed by directed links having varying thickness. While the size (radius) of pie charts encode the size of corresponding clusters, colors are used to show the current affiliation of people that make up each cluster.

A fifth type of view provided in the example of FIG. 1 is a people map. A people map provides a hierarchical graph that organizes people into organizational or functional units. In a people map, as shown in Figure 8, each person who is selected to be in the map is represented by a rectangle whose size is proportional to the connectivity of the person and whose color is determined by the diversity of the person. Since all people in a unit fill the rectangular space allocated for the unit, the connectivity of the unit is also proportional to the size of the space it fills. The dominant color in the space allocated to the unit indicates the diversity of unit's interaction or connections. For example, the AMS/PBI block in the lower left corner of the people map in Figure 8 has lower diversity than those of other comparable units, which have a higher level of diversity.

A sixth type of view provided in the example of FIG. 1 is a topical view. Topical views may include all other views that have been described so far, where views may focus on different

interaction topics ranging from general to specific. That is, each of the view types discussed so far displays a particular topical view involving a topic or an area of interaction among entities. While some of the general topics may include

5 execution, expertise, ideas, teamwork and advice, specific topics may include domain specific issues, such as hedge fund networks in finance, magnetic resonance imaging networks in medicine or skiing networks in recreational activities. Classifying e-mail or shared resources based on content gives
10 way to numerous topical interactions.

In a preferred embodiment of the views described above, when a graphical object, such as a box or a circle, is pointed to or otherwise indicated or selected by an input device, such as mouse, keyboard, voice recognition system, etc., a brief
15 summary of interactions of the corresponding entity is displayed dynamically within a pop-up information window or the like. In addition, selecting a graphical object by an input device causes a detailed view or additional information about the entity associated with the object to be provided. It should be
20 apparent to one of ordinary skill in the art that when a graphical object is pointed to or otherwise indicated or selected, the information of the corresponding entity may be presented in many different ways without departing from the scope or spirit of the present invention.

Interaction analysis 130 as shown in FIG. 1 involves generation of one or more of the views in an appropriate order as dictated by analysis tasks at hand. Some of the analysis tasks that may be supported by the process include: interaction management at organization, group and individual levels; integration of organizations, groups and individuals over time; client relationship analysis and management; critical resource identification; cluster analysis; and diversity analysis. In the embodiment of the invention described herein, not all interaction analysis tasks require the use of all views. While some of the analysis tasks can only be performed by information analysts who are experts in organization and people management, others can be performed as part of a discovery process by people who are members of the target audience.

An additional step that may be included to the methodology of the present invention in FIG. 1 is report and advice generation 140. Report and advice generation 140 involves presenting analysis results at an appropriate level of abstraction to the target audience. While domain knowledge is required to tailor reports or advice, this process lends itself in automating basic reports and advice.

The present invention has various useful applications. First, it may be used to understand roles and traits of entities, such as people or groups, within an organization where

entities interact with each other dynamically and possess attributes. Second, it may be used to integrate other entities into an existing organization in an efficient and effective manner, and help them develop and grow with the changing organization over time. Third, it may be used for client relationship management and analysis. Fourth, it may be used to restructure an existing organization to improve its productivity and profitability. And fifth, it may be used for identification of critical human resources. While these are only a few specific applications of the present invention, the underlying methodology, in general, may be used as an effective vehicle for organizational knowledge and/or intellectual capital management.

The hardware/software needed to implement the present invention generally includes the following components: (1) a networked computing infrastructure, (2) server side computing resources, and (3) client side computing resources.

Since the invention involves collecting interaction data from such diverse sources as surveys, e-mail logs, phone records and shared resource access logs, a networked computing infrastructure capable of supporting data collection by polling individuals or monitoring their interactions within a distributed environment is desired. Given that such computing infrastructures are commonly available in many organizations, most of the software needed to collect data can be developed by

using existing languages, utilities and/or tools in a platform-dependent manner with proper access to relevant databases.

The server side computing resources include the following preferred components: (1) database(s) capable of storing all
5 interaction, auxiliary and derived data; (2) a web server capable of authenticating information access requests, retrieving appropriate subsets of data from the database and sending the resulting data in an appropriate format to the client side requesting the information; and (3) a proprietary
10 code base implementing parts of the data extraction, view generation, interaction analysis and report/advice generation steps on the server side.

The client side computing resources include the following preferred components: (1) a set of generic technologies, such as
15 cookies and Java-enabled browsers; and (2) a proprietary code base implementing parts of the view generation, interaction analysis and report/advice generation steps on the client side.

Those skilled in the art will recognize that the method and system of the present invention has other applications, and that
20 the present invention is not limited to the representative examples disclosed herein. Moreover, the scope of the present invention covers conventionally known variations and modifications to the system described herein, as would be known by those skilled in the art.